Claims

[c1] 1. A method for adaptively fabricating a waveguide comprising:
(a) measuring misplacement of a photonic device relative to a substrate;
(b) generating computer readable instructions for using a plurality of graphics primitives to form the waveguide;
(c) photocomposing the waveguide on the substrate in accordance with the computer readable instructions.

[c2] 2. The method of claim 1 wherein (a) comprises representing an actual position of the photonic device by a translational error.

[c3] 3. The method of claim 2 where (b) comprises generating computer readable instructions to compensate for the translational error.

[c4] 4. The method of claim 2 wherein (a) comprises representing an actual position of an aperture of the photonic device by the translational error.

[c5] 5. The method of claim 1 wherein (a) comprises representing an actual position of the photonic device by a rotational error and a translational error, and wherein (b) comprises generating computer readable instructions to compensate for the rotational and translational errors.

[c6] 6. The method of claim 1 further comprising, prior to (a), forming markings on the substrate, wherein (a) comprises measuring the photonic device relative to the markings.

[c7] 7. The method of claim 1, wherein (b) comprises generating computer readable instructions identifying a reticle, and wherein (c) comprises using the reticle.

[c8] 8. The method of claim 7 wherein (b) comprises determining optimal graphics primitives and using the optimal graphics primitives for identifying the reticle.

[c9] 9. The method of claim 7 wherein (b) comprises generating the computer readable instructions for using the plurality of graphics primitives to form a waveguide having profiled end points, and wherein using the reticle comprises using a grayscale reticle.

[c10] 10. The method of claim 7 wherein (c) comprises using a wafer stepper.

[c11] 11. The method of claim 10 wherein (c) comprises maintaining the reticle in a stationary position and using the wafer stepper for moving the substrate.

[c12] 12. The method of claim 10 wherein (c) comprises providing a photoresist over the waveguide, exposing the photoresist to light through the reticle, and using the photoresist to pattern the waveguide.

[c13] 13. The method of claim 12 wherein (c) further comprises using the photoresist to pattern the waveguide by dry etching the photoresist and waveguide.

[c14] 14. The method of claim 12 wherein (c) further comprises providing a metallization layer between the waveguide and the photoresist, and, after exposing the photoresist to light through the reticle, wet etching the metallization layer, dry etching the waveguide through the etched metallization layer, and removing the etched metallization layer.

[c15] 15. The method of claim 10 wherein (c) comprises photocomposing the waveguide by exposing the waveguide to light through the reticle.

[c16] 16. The method of claim 1 further comprising, prior to (a), providing a substantially flat substrate.

[c17] 17. The method of claim 16 further comprising, prior to (a), positioning a photonic device comprising a vertical cavity surface emitting laser (VCSEL).

[c18] 18. The method of claim 17 further comprising, after (a) and before (c), providing a microlens over the VCSEL.

[c19] 19. The method of claim 1 wherein (a) comprises measuring misplacements of photonic devices comprising a VCSEL and a photodetector.

[c20] 20. The method of claim 19 wherein (b) comprises generating computer readable instructions for fabricating a substantially straight waveguide.

[c21] 21. The method of claim 19 wherein (b) comprises generating computer readable instructions for fabricating a waveguide comprising an adapted

portion.

[c22] 22. The method of claim 21 wherein (b) comprises generating computer readable instructions for fabricating a waveguide comprising two substantially straight portions coupled by the adapted portion.

[c23] 23. The method of claim 1 wherein (a) comprises representing an actual position of the photonic device by translational error, wherein (b) comprises generating computer readable instructions to compensate for the translational error, and wherein (b) comprises generating computer readable instructions for fabricating a waveguide comprising an adapted portion and two substantially straight portions coupled by the adapted portion.

[c24] 24. The method of claim 23 wherein (b) comprises generating computer readable instructions for fabricating a stretch region in one of the substantially straight portions.

[c25] 25. The method of claim 23 wherein the adapted portion comprises a straight stretch region and a translation bend region.

[c26] 26. The method of claim 25 wherein the translation bend region is offset in both the X and Y directions.

[c27] 27. A computer-readable medium storing computer commands for commanding a computer system to formulate computer readable instructions for using a plurality of graphics primitives to form a waveguide, the computer commands comprising:

(a) accessing an align file comprising data describing an actual position of a photonic device on a substrate;

(b) accessing a CAD flash file comprising data describing an ideal placement of graphics primitives on the substrate;

(c) accessing a reticle index comprising a plurality of reticle files, each reticle file comprising a list of available graphics primitives on a respective reticle;

(d) accessing an adaption type file comprising data on reticle overlapping for positional offset error of the photonic device; and

(e) using the align file, the CAD flash file, reticle index, and the adaption type

file to provide computer readable instructions for (i) selecting a reticle and (ii) controlling a wafer stepper supporting the reticle and a light source positioned opposite the reticle for supplying light through the reticle to the substrate.

[c28] 28. The medium of claim 27 wherein (e) (ii) comprises specifying wafer stepper exposure locations.

[c29] 29. The medium of claim 28 wherein (e) (ii) comprises specifying reticles to be used in wafer stepper passes.

[c30] 30. The medium of claim 29 wherein (e) (iii) comprises specifying exposure parameters for each of a plurality of waveguide segments.

[c31] 31. The medium of claim 30 wherein the exposure parameters comprise positional coordinates and reticle opening offset.

[c32] 32. The medium of claim 31 wherein the exposure parameters further comprise exposure and focus.

[c33] 33. A reticle comprising: a plurality of graphics primitives, at least one of the plurality of graphics primitives comprising a tapered end.

[c34] 34. The reticle of claim 33 wherein a taper of the tapered end comprises a shaped taper.

[c35] 35. The reticle of claim 34 wherein the shaped taper comprises a widened taper.

[c36] 36. The reticle of claim 34 wherein the shaped taper comprises a narrowed taper.

[c37] 37. The reticle of claim 34 wherein the shaped taper comprises a rounded taper.

[c38] 38. The reticle of claim 34 wherein the shaped taper comprises an angled taper.

[c39] 39. The reticle of claim 33 wherein a taper of the tapered end comprises a profiled taper.

[c40] 40. The reticle of claim 39 wherein the profiled taper comprises a shaped and profiled taper.

[c41] 41. A method for fabricating a waveguide comprising:
selecting a reticle comprising a plurality of graphics primitives, at least one of the plurality of graphics primitives comprising a tapered end;
using computer readable instructions for photocomposing the waveguide through selected graphics primitives of the reticle,
the computer readable instructions comprising instructions designed to ensure that, for each of at least some pairs of adjacent photocomposed waveguide segments, at least one tapered end of one waveguide segment overlaps an adjacent end of the other waveguide segment.

[c42] 42. The method of claim 41 wherein the computer readable instructions comprise instructions designed to ensure that, for each of at least some pairs of adjacent photocomposed waveguide segments, a tapered end of one waveguide segment overlaps an adjacent tapered end of the other waveguide segment.

[c43] 43. The method of claim 41 wherein a taper of the at least one tapered end comprises a shaped taper.

[c44] 44. The method of claim 43 wherein the shaped taper is a widened taper or a narrowed taper.

[c45] 45. The method of claim 43 wherein the shaped taper comprises a rounded taper.

[c46] 46. The reticle of claim 43 wherein the shaped taper comprises an angled taper.

[c47] 47. The method of claim 41 wherein a taper of the at least one tapered end comprises a profiled taper.

[c48] 48. The method of claim 47 wherein the profiled taper comprises a shaped and profiled taper.

[c49] 49. A waveguide comprising a plurality of waveguide segments, each of the plurality of waveguide segments comprising a tapered end and being adjacent to at least one other of the plurality of waveguide segments.

[c50] 50. The waveguide of claim 49 wherein a taper of the tapered end comprises a

shaped taper.

[c51] 51. The waveguide of claim 50 wherein the shaped taper comprises a widened taper.

[c52] 52. The waveguide of claim 50 wherein the shaped taper comprises a narrowed taper.

[c53] 53. The waveguide of claim 50 wherein the shaped taper comprises a rounded taper.

[c54] 54. The waveguide of claim 50 wherein the shaped taper comprises an angled taper.

[c55] 55. The waveguide of claim 49 wherein a taper of the tapered end comprises a profiled taper.

[c56] 56. The waveguide of claim 55 wherein the profiled taper comprises a shaped and profiled taper.